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ABSTRACT

A psychological model can show the technical writer how to present information for effective communication by explaining how readers perceive, understand, learn, and remember. The principles underlying the model are the reader's psychological set, the mind's pattern-forming tendencies, the span of short-term memory, and the mind's need for reinforcement. The psychological set explains the disposition of readers to think or act in a particular way, and interference occurs when a communication does not match the reader's mind set. The main reason people read technical literature is to know how to do something, so technical publications should be task oriented. Gestalt psychology suggests that the mind tends to seek meaningful patterns in perceiving, understanding, learning, and remembering. Therefore, the technical writer's objective should be to supply cues for forming helpful patterns and to avoid cues that may form misleading patterns. The fact that the capacity of short-term memory is 7 plus or minus 2 items has numerous implications for presenting information: sentence length, number of items to include on a chart, and the number of parts into which to divide a comprehensible whole. Information is simple when the number of items presented does not exceed the span of short-term memory. Reinforcement helps the reader review material, verify interpretation, and see information in alternative ways. Technical writers should organize information so it will be easy for the reader to review. (HOD)

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USING EXPERIMENTAL PSYCHOLOGY IN TECHNICAL WRITING

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guished Technical Communication"

The psychology of learning is the foundation for the human factors of technical publications. This paper describes that foundation, whose five pillars are the principles of psychological set, pattern formation (Gestalt), short-term memory span, meaningfulness, and reinforcement. These principles define information ease of use by forming a model of the way the reader's mind works; the reader can better understand, learn, and remember information that is presented to fit the model.

In their classic style manual, *The Elements of Style*, Strunk and White refer only once to reader psychology—when they give the following argument (in favor of putting statements in positive form):

Consciously or unconsciously the reader is dissatisfied with being told only what is not; he wants to be told what is. Hence, as a rule, it is better to express even a negative in positive form.¹

The psychology here may be weak, but the *method* of appealing to psychology for support is not.

An instructor needs such support even more than an author does—for responding face-to-face in the classroom. To develop a course on "Writing for Reader Understanding," I wanted to know the psychological principles underlying effective communication. So I turned to books on the psychology of perception, cognition, learning, memory, and problem solving.² I found there such a coherent explanation for why good writing is good that I decided to use psychology as the very foundation of the course.

In this paper I construct a psychological model of the reader that includes:

The reader's psychological set
The mind's pattern-forming tendencies
The span of short-term memory
What is meaningful to the reader
The mind's need for reinforcement

By explaining how readers perceive, understand, learn, and remember, the model shows us how to present information for effective communication.

HOW IS THE READER SET?

The principle of psychological set is the readiness of an organism to make a particular response, the disposition of readers to think or act in a particular way.³ Readers' set is determined by their prior experience and by their needs. *Prior experience* obviously refers to the past—how has their past determined their set? What has happened to them before they encounter your writing? How much experience, if any—and what kind—have they had with the subject? Less obviously, *needs* refer to the future—how does their desired future determine their set? What has to happen as a result of their reading your writing, in order for their needs to be satisfied?

If you fail to take account of readers' set—the set that exists when they first come to your writing, before they've read a word of it—their response may be different from what you hope for. You may get puzzlement over technical details you thought would enlighten them; hunger from omitted details you left out to avoid stuffing them; irritation over humor you provided to entertain them.

When what you say—or how you say it—doesn't match your readers' set, there's *interference*. Some is unavoidable; you can't know perfectly your audience's past or desired future. But what you write *becomes* their past; it will influence their set for what they read next. Interference here is avoidable:

- If you've used one term for an idea, they'll expect you to continue to use it; when you slip in an "elegant variation," they'll wonder whether you're referring to the same idea, or to something else.
- When you use an -ing verb for the first three items in a list, they'll expect the same in the fourth item; switching to a -tion noun causes interference.
- By their prominence, headings, labels, captions, and lead-in sentences determine the reader's response to what follows. Meaningful ones will either lead or mislead, depending on whether they're consistent with what follows. Garbled ones fail to lead at all, but they too set the reader up—to grumble and to expect the worst.
- When an illustration must read from right to left, or from bottom to top, say so! By alerting your readers, you establish a momentary set to replace their well-established disposition to read from left to right, top to bottom.

The most important need of the reader is to know how to *do* something, to accomplish a necessary task; that's the main reason people read technical literature. Where I work, we say our readers are "task-oriented"—and we recognize that our publications have to be task-oriented too. We must thoroughly

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understand the particular tasks we're writing about. But, in general, we know that when readers are dominated by the need to do a task:

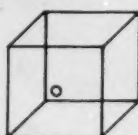
- They consider the technical manual to be a necessary evil—they'd like to get the job done without it, but they know they can't.
- They want to find quickly the specific information they seek; they want immediate relevance to what they have to do—any preliminary information provided must be essential.
- They expect information to be presented in the order and in the form it's needed for doing the task.

When what you say and how you say it match the reader's set, there'll be no interference in the communication.

WHAT PATTERN WILL THE READER FORM?

Gestalt psychology says that the mind tends to seek meaningful patterns—in perception, in understanding and learning, in remembering. It says that people learn best when they can relate new information to something they already know: "A person who has learned with understanding learns new tasks much more readily than a person who learned by rote."⁴

The mind seeks one meaningful pattern ("Gestalt") at a time. For example, there's more than one orientation for the box in this figure, but you can see only one of them at a time:



The pattern is called the *figure*; all else in the field is the *ground*. The figure-ground principle has implications for the purely visual aspects of page layout. Headings, highlighted phrases in text, and other devices that visually emphasize particular information on a page fail when overused, because the distinction between figure and ground is lost. When everything is important, nothing is important.

The mind seeks a *good Gestalt*—a pattern that is regular (predictable, harmonious), stable (unambiguous—the box above isn't stable), simple (having the smallest practical number of parts), and complete (accounting for as much of the information as possible). Gestalt psychologists formulated laws of organization by which the mind forms a good Gestalt.

One of those laws is implied in this statement from a book by Ernst Jacobi (who often appeals, implicitly, to Gestalt psychology): "The major reason anything is important to anybody is the existence of a problem, and the best way for a writer to stimulate his reader's interest is by defining and stating his problem."⁵ This is the *law of closure*—the mind seeks to complete something that is incomplete. It adds missing parts to a spatial configuration: "n v r t h l s." It seeks a solution to close out a problem. The tension aroused by incompleteness is the source of the "hook" in writing of many kinds.

The *law of similarity* underlies what Jacobi says about parallel construction:

Mixed constructions—also called nonparallel or shifted constructions—are among the most common faults that block understanding. Our minds are trained to expect parallel

construction. When our expectations are disappointed, we tend to become confused.⁶

Similar things, or similarly presented things, tend to be perceived as parts of a single pattern. We cause conflict when we present similar or related things in dissimilar or unrelated ways; we're giving contradictory cues for forming a pattern.

The introductory part of a passage is crucial for the reader's pattern formation, as in this example from Jacobi:

The method of conveying information by starting out with a conclusion is called the deductive method. It is the method used in everyday learning and thinking, and it should be used by every writer who cares about reaching his reader's mind.⁷

Given the conclusion, readers can proceed by relating the details to it. But given the details first, they'll have to look for something to relate them to. Finding no pattern will frustrate them; finding a wrong one will mislead. Given an outline of the whole that follows, readers are less likely to get lost in the parts, especially if we tell them occasionally, "You are here (in relation to the whole)."

Readers seek patterns; that's the way the mind works. Writers can either cooperate with the fact, or resist it. The communicator's objective should be to supply cues for forming helpful patterns—and withhold cues for forming misleading ones.

WILL THE READER'S SHORT-TERM MEMORY BURST?

Short-term memory is what we use when we hold an unfamiliar telephone number temporarily in mind while we dial it, or when we listen to a speaker, or read a sentence. The capacity of short-term memory is 7 ± 2 items.⁸ This fact has numerous implications for presenting information: sentence length, number of items to include on a chart, number of parts into which to divide a comprehensible, memorable whole—and the number of psychological principles to teach in a class, or talk about in a paper at the ITCC.

The "length" of a sentence is determined, I believe, by its demands on the reader's short-term memory. Says Jacobi: "Long sentences may become troublesome not because they contain too many words but because they contain too many ideas."⁹ The difficulty of defining "idea" may be one reason that exponents of short sentences for readable writing (such as Rudolf Flesch) recommend we count words—we can do that.

But the following pair of sentences demonstrates the oversimplicity of word counting. One sentence has three times as many words as the other, yet I've found that people can recite them about equally well:

The white elephant with the green umbrella in its trunk trotted happily along the rock wall of the small village in the Indian jungle.

Eight small, rough, silently bounding green cubes disappeared.

Clearly, the elephant sentence breaks up into phrases. People form one image (one "idea") of "the white elephant," or even of "the white elephant with the green umbrella in its trunk." Obviously ideas can be made up of numerous smaller ideas. In fact, people who need to hear these sentences several times use the repetitions to build up larger and larger units (i.e., to "recode" them), until the number of units is within the capacity of short-term memory. And people who can repeat

either sentence the first time don't necessarily have a greater capacity; they may be better recoders—better able to picture, for example.

Common sentence patterns (such as subject-verb-object) require less recoding, and thus are easier to remember, than unusual constructions. The green-cubes sentence is backhanded—the mind has to pigeonhole all the modifiers until the subject is revealed.

Of course, we're concerned in reading, not with remembering sentences verbatim, but, as Jacobi says, with the sentences not "becoming troublesome." But I think that exceeding the span of short-term memory causes most of the trouble; to understand a sentence, readers must hold all of it in short-term memory.

HOW MUCH MEANING WILL THE READER FIND?

To demonstrate the capacity of short-term memory, I entertain my students with a few "uncontrolled experiments."¹⁰ I have them recite sentences and simple lists of varying length and content. For example, compare these lists:

kol, naz, san, fis, cav, yeg
truth, finance, charm, work, health, division
ball, flower, mirror, package, hair, rock
car, wheel, road, map, station, gas

The lists are short enough that most people can recite each of them after one hearing. But as items are added, there comes a point where one hearing is insufficient. That point comes later in subsequent lists—as I move from nonsense syllables to abstract words, to concrete words, to related concrete words.

These exercises demonstrate that a long list of familiar, concrete, or related items is as easy to remember as a shorter list of unfamiliar, abstract or unrelated items. Or, generally, the more meaningful the material, the easier it is to remember—and to understand and learn. This, of course, is a central theme of Gestalt psychology.

Information is meaningful when it is familiar, it can be pictured, and its parts are related:

- You improve the chance that information is *familiar* to your audience when you use the vocabulary they use; when you minimize new terminology and define it in terms of the old; when you explain new ideas in terms of ideas they already understand.
- You help your audience *picture* information when you use concrete language—language that appeals to the senses. Show an actual picture, if possible; if not possible, draw a picture in words—give examples, provide an analogy to a situation the audience can imagine.
- You show your audience the *relationship* of the parts when you select them, first, because they really are related, then organize them to reveal the relationship in a single Gestalt.

Information is simple when the number of items presented doesn't exceed the span of short-term memory, and all the items are meaningful. More than about seven items—even familiar ones that can be pictured—will initially swamp the reader's mind. There are too many to form a Gestalt. You assist the reader by recoding the items into a smaller number of groups.¹¹ Recoding *must* be done—either by you or by the reader—before the reader can comprehend the whole.

The greater the familiarity, concreteness, and relatedness of information, the more readily readers can do the recoding themselves:

- What is *familiar* is easily associated with information in long-term memory, and the association can be used in recoding. Such association is possible with nonsense syllables only to the extent that momentary sense can be imagined for them.
- What is *picturable* can be represented pictorially, and a mental picture can economically portray several objects (though not a thousand)—a white elephant holding a green umbrella in its trunk.
- The *relationship* among items evidently related can be used in recoding—car, wheel, road . . . "going for a drive."

When readers can easily recode information into few enough units for short-term memory, the writer has probably been simple enough.

We've been considering *cognitive* meaningfulness—the reader's being able to understand and process information. But meaningfulness also includes being interesting, motivating the reader. That, in fact, is the theme of Jacobi's book: "Clarity isn't enough . . . to be effective your communication has to be interesting."¹² But presenting relevant information lucidly is the first thing writers should do to keep their readers awake and alert.

IS THE READER REINFORCED?

Perhaps programmed-instruction (PI) texts are writing's most thorough application of the principle of reinforcement. PIs exploit the idea that the reader should immediately respond to instruction, and that correct responses should be acknowledged and incorrect responses remedied.

But in what ways can we use reinforcement in more standard technical writing to improve understanding, learning, and memory? Reinforcement includes:

- Repetition—a certain amount is essential to mastering new material. The consolidation of new information into long-term memory takes time—minutes at least.¹³ The writer can't economically provide all the repetition actually required (anyway, readers wouldn't stand for it), but the classical structure of introduction-body-summary gives the writer a chance to repeat main ideas at least three times.
- Verification—checking whether the material has been understood or interpreted correctly.¹⁴ Verification ultimately depends on *doing something*, whose results the reader can observe and judge for success or failure. The writer should judiciously indicate things for readers to do and ways for them to judge results.
- Appealing to more than one sense.¹⁵ Showing reinforces telling; an example reinforces a definition; a side-view reinforces a view from the front; a motor action reinforces passive cognition.

There's a limit to how much reinforcement we can give. Readers are responsible for reviewing the material, for doing an exercise, for imagining alternatives. But we can help by organizing the information so it's easy to review, by providing examples to serve as exercises, by indicating some alternatives.

SUMMARY SKETCH OF READER PSYCHOLOGY

Psychology gives us a coherent set of principles that explain generally why good writing is good, and that can guide our attempts to write well. From these principles we can shape a model of the reader:

- Readers have a mental set, determined by prior experience and future needs. There's interference when what we say, or how we say it, doesn't match that set.
- Readers must form one meaningful pattern at a time. Our job is to ensure they form the pattern we intend.
- Readers have a short-term memory span of 7 ± 2 items. We should recode complex information into mind-sized portions.
- Readers find more meaning in the familiar, the picturable, the related. The more meaningful we make information, the easier it is for readers to recode it for themselves.
- Readers require reinforcement. We can help them review the material, verify their interpretation, and see information in alternative ways.

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